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Notes on the Breeding Biology of the White-Throated Swift in Southern California

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Abstract.—Reproductive activities of White-throated Swifts (*Aeronautes saxatalis*) were examined from 1997 to 2006 at two nest sites in a human-made structure in southern California. The start of egg-laying was from 27 April to 30 May and hatching of the first chick ranged from 21 May to 23 June; all chicks had fledged by late July, 42–43 days after hatching. The annual molt of adults began in early June and broadly overlapped with the chick-rearing period. Year to year adult survival was minimally 73.9% and nesting pairs showed strong mate and nest site fidelity; pairs reused nests up to five consecutive years. The composition of the arthropod food (insects and spiders) brought to nestlings was different in the periods 1997–2000 and 2001–2004 but prey size was similar in both periods. The onset of breeding was more varied from year to year than the start of the primary feather molt suggesting differing environmental stimuli for these important components of the annual cycle.

The White-throated Swift (*Aeronautes saxatalis*) is a widespread and familiar element of the southern California avifauna. Its staccato chattering vocalization often announces its presence, searching for aerial prey high overhead, long before visual contact is made. In recent decades, this swift has utilized human-made structures as buildings, bridges and highway overpasses for nesting and roosting (Collins and Johnson 1982; Ryan and Collins 2000). In so doing it has expanded its local range farther from its more traditional rocky cliff sites. Recent studies have documented the molt and weight pattern of desert-inhabiting White-throated Swifts (Marin 2003) and the diet and behavior of coastal birds (Rudalevige et al. 2003; Ryan and Collins 2003a, b, c). Still there remains a paucity of information about the reproductive biology of the species (Ryan and Collins 2000). This is in large part due to the inaccessibility of their nests in natural cliff sites; rock-quarrying techniques had to be employed by early collectors to obtain the first nest and eggs (Hanna 1917; Bradbury 1918). The utilization of human-made sites by these swifts holds promise of better access to breeding sites and the acquisition of more information on their reproductive activities. In Europe, breeding colonies of the Common Swift (*Apus apus*) (Lack 1956; Gory 1987; Kaiser 1992), Pallid Swift (*A. pallidus*) (Boano and Cucco 1989) and Alpine Swift (*Tachymarptis melba*) (Arn-Willi 1960), situated in human-made structures have provided the necessary access for detailed study. Until a similar colony of White-throated Swifts is established, data on their reproductive activities will be characterized, as in this study, by regrettably small sample sizes.

Methods

The data presented here are based on a 9-year study of White-throated Swifts nesting in a human-made highway overpass in Glendale, Los Angeles County, California (34° 11.16' N. 118° 13.01' W; elevation 361 m) between 1997 and 2006. The land-cover type

within 15 km of the study location is largely urban with some areas of chaparral, coastal scrub and montane hardwood forest (Davis et al. 1998). The swifts entered the nest sites through 12.3 cm diameter drainage holes located on the underside of the overpass. There were eight such holes in the overpass of which 5–7 appeared to be utilized each year by nesting swifts. This was determined by observation of adults entering/leaving holes, fecal material below the hole or hearing vocalizing nestlings within. Only a single pair of swifts utilized any given opening. Two of the holes were accessible from inside making detailed observations possible each year. This program of study included capture and banding of both adults and nestlings with numbered aluminum bands issued by the U. S. Geological Survey (Bird Banding Laboratory), as well as documentation of chick growth and diet as indicated by analysis of food boluses brought to nestlings; adult body weight and molt were also studied. Food boluses were stored in 70% ethyl alcohol for later examination. Prey sizes (head to abdomen length omitting antennae and caudal appendages) were measured to the nearest 0.1 mm using an ocular micrometer. Adults and nestlings were weighed with a Pesola spring balance to the nearest 0.1 g and flattened wing lengths measured with a stopped wing rule to the nearest 1.0 mm. Egg weights were obtained with a portable electronic balance to 0.01 g.

The molt of adult primary feathers was scored using a numerical system where each feather is given a value from 0 to 5 (Newton 1966). In swifts, primary molt is usually symmetrical so only the primaries of the right wing were scored in this study. An unmolted feather was scored as 0, a dropped or missing feather as 1, an emerging new pin feather < ½ regrown as 2, a new feather ½ to ¾ regrown and partially emerged from the sheathing as 3, a nearly fully (> ¾) regrown feather with only some sheathing at the base as 4, and a fully regrown new feather as 5. A maximum score for replacement of the 10 primaries would thus be 50. A molt score of 20 might be achieved by having primaries 1–3 new (15), the fourth primary ¾ regrown (3) and the fifth primary being present as a short new pin feather (2) and primaries 6–10 old and unmolted (0).

Results and Discussion

Adult Body Weight

Nine adult White-throated Swifts of unknown sex were captured and weighed on 19 occasions in June–July 1997–2006. The mean body weight was 32.5 g (SE = 0.54). This is similar to other data for this species (Table 1) including birds from both desert (Marin 2003) and coastal (Collins, in, Dunning 1993) areas of southern California. Individuals weighed on 2–5 occasions in different years varied in weight from –4.6 to +8.5 g (mean 2.64, SD = 2.53) or about 8.2% of the mean for a coastal population (Collins, in Dunning 1993). The greatest annual difference in body weight was from an individual which weighed 29.8 g on 13 July 2005 and 38.3 g on 15 June 2006. Seasonal variation in body weight of up to 28.7% between the highest and lowest values were reported for a desert

Table 1. Body weights of adult White-throated Swifts in southern California.

Mean weight (g)	SE	n	Range	Source
31.7	0.23	89	26.5–37.2	Marin 2003
32.1	0.55	20	27.8–36.0	Collins, in Dunning 1993
30.5	–	19	29.0–33.5	Bartholomew et al. 1957
32.5	0.54	19	29.0–38.5	this study



Fig. 1. Nest, eggs, and developing chicks of White-throated Swifts: a – eggs show spotting by ectoparasite excrement. b – 8–9 day old chicks with developing semiplume feathers seen as subcutaneous dots. c – 23–24 day old chicks with grey semiplumes partially overgrown by incoming contour feathers. d – 38–40 day old chick with sheathing still present at base of some dorsal contour feathers.

population of White-throated Swifts (Marin 2003). This is less than the variation recorded for some other species of swifts (Gladwin and Nau 1964; Naik and Naik 1966).

Nests and nest parasites

All of the White-throated Swift nests observed at this location were shallow saucers of plant material and feathers glued together with saliva (Figure 1a). A strip of cellophane was incorporated into one nest. All the material was presumably gathered on the wing; construction of the nests was not observed. Two nests measured 8×8 cm, and 9.4×9.4 cm rim to rim and were 2.5–2.8 cm deep. New nests used for the first time contained less material and were often nearly torn apart by the normal movements of older nestlings. Nests that survived and were re-used in subsequent years (up to 5 successive years) became more substantial with the addition of new material each year. At the mouth of one of the other ventilation holes a dead young swift was observed tangled in

string, presumably brought in by the adults as nesting material. A similar incident was reported previously at another location (Collins and Johnson 1982). These observations are in general agreement with earlier descriptions of White-throated Swift nests (Ryan and Collins 2000 and references therein).

Parasites

Infestations of mites (Acarina) and bedbugs (Cimicidae) were noted in varying intensities in different years. They were observed in substantial numbers on nests, eggs, and chicks in some years and nearly absent in others. These have been previously identified as *Mimenstathia aeronautou* (mites) and *Snyxenoroderus comosus* (bedbugs) (Peterson et al 1980; Usinger 1996). Samples of the bedbugs collected in 2006 were tested at the USDA National Wildlife Research Center and all were negative for exposure to West Nile Virus (WNV; P. Oesterle, pers.com.). Samples of the feather louse *Dennyus bruneri*, endemic to White-throated Swifts (Carriker 1954), were collected from both adults and late stage nestlings.

Eggs and Clutch Size

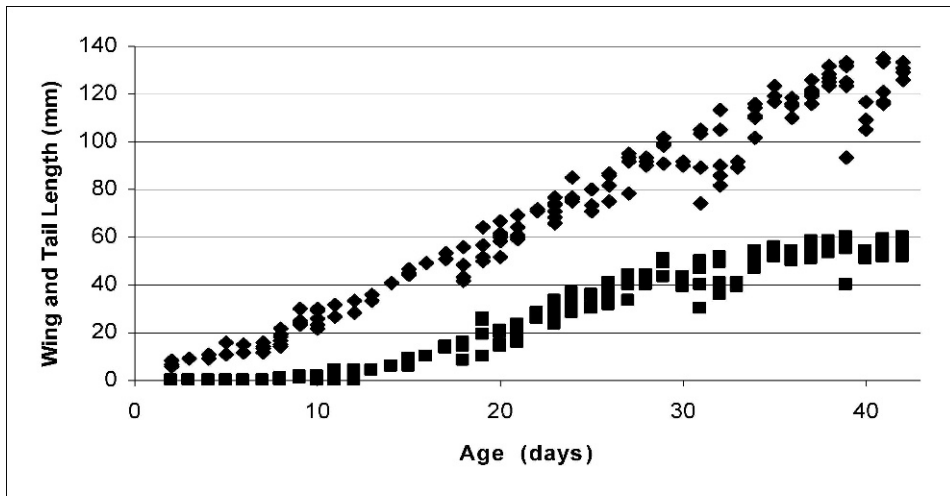
The eggs of the White-throated swift, like those of other swift species (Chantler 2000), were uniformly creamy white without gloss although they sometimes became spotted by excrement of ectoparasitic cimicids (Figure 1a). They showed little taper and have been described as varying from elongate ovate to cylindrical ovate (Bent 1940). In previous studies they have ranged in size from 18.6–22.6 × 12.9–14.7 mm (Ryan and Collins 2000). Twelve partially incubated eggs in this study weighed, on average, 1.95 g (SE = 0.04, range 1.7–2.2 g). Fresh egg weight of 27 eggs from southern California was 2.01 g (SE = 0.04) or 6.3% of adult weight (M. Marin, in Ryan and Collins 2000). Hatching success was 82% (14 of 17 eggs). Unhatched eggs remained in the nest for up to two weeks until they were eventually crushed or accidentally ejected.

Clutch size for four nests initially found with eggs was 4, 4, 4 and 5 eggs. Brood sizes in thirteen nests containing chicks when initially found ranged from 2 to 4, averaging 3.38 (SD = 0.87). These values are in close agreement with previously recorded clutch sizes of 3–6 but normally 4–5 (Hanna 1917; Bradbury 1918; Bent 1940).

Chick Development

At hatching, White-throated Swift chicks were pink-skinned, devoid of any natal down, with eyes closed and a prominent egg-tooth. Their eyes were partially open by day 8–10 post hatching (Figure 1b) and fully open by day 15. The egg-tooth was still observable on day 8–9 but gone by day 18–19. The first feather coat was a covering of moderately long light grey down-like semiplumes. These were observable as subcutaneous dark dots by day 7–8 (Figure 1b) and erupted through the skin by day 11–13. The semiplumes were fully developed by day 20–23 but were covered over by the emerging contour feathers by day 28. The tracts of the body contour feathers were observable under the skin by day 11, and emerged through the skin by day 15. These pin feathers began to erupt through their sheaths by day 22–24 at which time they began to appear through the semiplume covering of the chicks (Figure 1c). The contour feathers appeared fully developed except for some remaining sheaths at their base by day 32–33; this sheathing was entirely gone by day 40 (Figure 1d). The primary flight feathers emerged through the skin on day 8–11 and started to erupt through the pin feather sheaths by day 15–18. They had emerged from the sheaths for half their length by day 23. The outermost

a.



b.

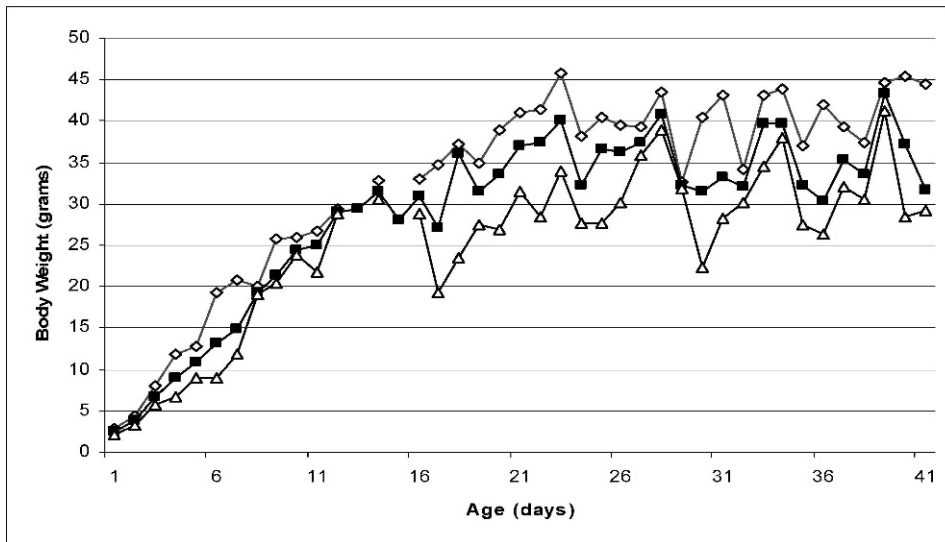


Fig. 2. Growth of (a) wing, tail and (b) body weight of White-throated Swifts in southern California. a. wing length shown by black diamonds; tail length by black squares b. Daily mean body weight shown by black squares. Clear symbols indicate daily maximum (diamonds) and minimum (triangles) weights.

three primaries had some sheathing at their bases as late as day 39 but this was gone by day 42. Tail feathers emerged through the skin at day 9–10 and began erupting through the sheaths at day 17–18.

The growth of the wing and tail was rapid and nearly linear for most of the growth period (Figure 2a). By day 42 the wing lengths of two chicks closely approximated that of adults captured in this study (131–143 mm, mean = 138 mm); three other chicks at ages of 40–41 days had only reached wing lengths of 105–117 mm or 76–85% of adult wing length. Tail feathers reached full adult length of 54–58 mm by day 35–37 (Figure 2a).

The pattern of plumage development in White-throated Swifts closely approximated that documented for the Common Swift (Lack and Lack 1951, 1954). The absence of natal downs in swifts has also been previously documented (Collins 1978).

White-throated Swift chicks increased in body weight from about 2 grams at hatching to as much as 46 grams prior to fledging. From day 2 to day 17 chick growth was nearly linear and increasing at a rate of 2.0 grams per day (Figure 2b). Thereafter, the pattern of growth is highly variable with some individuals reaching a peak weight in excess of 40 g. by day 24 which is >123% of adult mean weight (Table 1) followed by a decline to 30–35 g prior to fledging at day 42–43. This pattern of weight recession has been noted previously in both swifts and swallows (Ricklefs 1968). Weight recession has been attributed to maturation of the integument and feathers accompanied by decrease in water content (Ricklefs 1967, 1968). In this study however, some individuals did not reach peak weight until much later (> day 32) and three chicks reached their peak weight of 43.9–45.5 g at days 40–41 immediately prior to fledging.

What has been termed “abnormal growth” has been documented in a number of avian species (Ricklefs 1976) including swifts (Lack and Lack 1951). It has been largely attributed to a reduction in food delivered to the young, particularly early in the breeding season when normal food supplies are low or not available (Lack and Lack 1951; Ricklefs 1976). Such abnormal growth is often manifested in lower peak weights achieved by the chicks as well as a delay in the time to reach the peak weight. In addition, the rate of growth of the wing and tail feathers may also be slowed (Ricklefs 1976). In this study, the abnormal growth of some White-throated Swift chicks, is illustrated here (Figure 2b) by lower peak weights, delay in the time to reach peak weight and a slower than typical growth of the wing and tail. This is most likely attributed to observer disturbance and, particularly, the capture or recapture of adults returning to the nest with food for the chicks. This in turn may have resulted in a temporarily decreased food delivery to the young and the observed abnormal growth. The more natural growth pattern, shown by some White-throated Swift chicks, was characterized by early acquisition of peak weight followed by moderate weight recession and fledging at or near adult weight.

Asynchrony among and between broods

The pattern of egg laying and incubation was not observed in this study. Elsewhere, egg laying takes place over 4–6 days, incubation does not start until the clutch is complete and hatching is asynchronous (Ryan and Collins 2000 and references therein). In the broods observed in this study, the chicks appeared to be of unequal ages suggesting that hatching took place over 2–3 days in broods of 4. The size differences were more apparent when the chicks were older (>14 days old) and may have been accentuated by nestling competition for food. However, no chicks were observed to suffer severe growth impairment or starvation attributable to such intra-brood competition.

Annual synchrony among broods was generally high with the median age of the chicks in the two nests under observation each year usually differing by only one to five days. However, in 1999, the inter-brood difference in age was 9 days and in 2004 it was an exceptional 13 days. The overall annual difference in age of the broods was 4.8 days (range 1–13 days, SD = 4.2).

By backdating from the age of the oldest chick in the study broods and, assuming a mean incubation period of 24 days (H. Richardson, unpublished, in Ryan and Collins 2000), it was possible to calculate the date of hatching of the first chick and the date of laying of the first egg. The date of laying of the first egg ranged from 27 April (in 2005) to



Fig. 3. Adult White-throated Swift carrying a bolus of nestling food resulting in a distension of the floor of the mouth. Photo by Kevin Smith; reproduced by permission.

30 May (in 2000) with a median date of 13 May; hatching of the first chick ranged from 21 May to 23 June (median 6 June). A pair, which had remained together for two consecutive years, had laying dates of 22 May (in 2005) and 8 June (in 2006).

Food

Swifts of the subfamilies Chaeturinae and Apodinae, including White-throated Swifts, bring food to nestlings in the form of a bolus of aerial arthropods gummed together with saliva. The bolus, consisting mostly of insects and some spiders, is carried in the mouth which results in a visible distension of the floor of the buccal cavity when adults are carrying food to nestlings (Figure 3). The first depiction of this in White-throated Swifts is a sketch by Louis Agassiz Fuertes made in the Chisos Mountains, Texas, in 1901. This sketch (Image # 215804, American Museum of Natural History Library) has been reproduced by Castro and Burke (2007). All prey items are caught on the wing at unknown distances from the nesting location. Each bolus can contain a wide array of prey taxa which range in number from 4–5 larger items to over 200 smaller ones (Rudalevige et al. 2003). During the study period nine such boluses were collected from adults returning to the nests to feed nestlings. Five boluses (1–5) collected between 1997 and 2000 were analyzed previously (Rudalevige et al. 2003); analysis of an additional four boluses (6–9) collected between 2001 and 2004 is included here. One bolus measured 12×15 mm and weighed 0.6 g.

In the initial analysis (boluses 1–5) 547 prey items were identified including spiders and seven orders of insects distributed among 50 families or superfamilies (Rudalevige et al. 2003). Hemiptera made up 41.9% of the prey items while Diptera (26.4%) were the most

Table 2. Annual variation in prey types captured by White-throated Swifts from the same nesting location in southern California.

	1997–2000 ^a (Boluses 1–5)	2001–2004 (Boluses 6–9)
Hymenoptera	36 (6.58%)	58 (15.34%)
Hemiptera	229 (41.86%)	104 (27.51%)
Diptera	120 (21.94%)	206 (54.49%)
Coleoptera	7 (1.28%)	6 (1.58%)
Psocoptera	147 (27.24%)	-0-
Lepidoptera	1 (0.18%)	-0-
Thysanura	1 (0.18%)	1 (0.76%)
Araneae	4 (0.73%)	3 (0.79%)
Total prey items	547	378
Prey Items/bolus	4–231	44–126
Mean prey items/bolus	109.4	94.50
SD	103.19	35.37

^afrom Rudalevige et al. 2003

diverse with 22 families represented. The four additional boluses (boluses 6–9) contained 378 individuals distributed among five orders of insects and three spiders; family level identifications were not attempted. A comparison of these two data sets (Table 2) shows substantial variation in prey types captured by swifts from the same nesting location in different years. Coleoptera, Thysanura, and Araneae were captured in about the same frequency in boluses 6–9 as in boluses 1–5 (Table 2). Hymenoptera and Diptera were more than twice as frequent in boluses 6–9 while Hemiptera made up a substantially greater percent of the prey items in boluses 1–5 (41.9%) than in boluses 6–9 (27.5%). Psocoptera which made up 27.2% of the prey items in boluses 1–5 were entirely absent from boluses 6–9.

Similar year-to-year variation in the taxonomic composition of swift prey items has been noted in comparisons of boluses obtained from Common Swifts in England (Lack and Owen 1955). Prey diversity also varied in a comparison of prey taken in geographically separated populations of the Alpine Swifts in Europe and South Africa (Collins et al. 2009). There was also substantial bolus to bolus variation in prey type captured during a single breeding season by the Plain Swift (*Apus unicolor*) in the Canary Islands (Garcia-del-Rey et al. 2010).

The size of prey items taken by White-throated Swifts was much less variable than prey taxa between boluses 1–5 and boluses 6–9 (Figure 4). The mean prey size was 3.9 mm and 3.7 mm respectively (Table 3). These means are not significantly different ($T = 1.94$, $p > .05$). The largest prey item identified in boluses 1–5 was 16.7 mm but only 9.9 mm in boluses 6–9. The modal size of prey items was 3 mm in both sampling periods (Figure 4). The larger prey items (> 12 mm) in boluses 1–5 were honeybees (*Apis mellifera*) which made up three of the four prey items in one bolus. Both drone and worker honeybees have been recorded in the diets of other swifts (Lacey 1910; Hess 1927; Bartels 1931; Morse and Laigo 1969; Collins et al. 2009).

The taxonomic diversity of prey items taken by White-throated Swifts in different years at the same location, as well as the bolus-to-bolus variation suggests that these swifts are opportunistic foragers which readily exploit localized or seasonal abundances of prey within a preferred size range. This is in agreement with data from other swift species (Lack and Owen 1955; Thirumurthi and Krisna Doss 1981; Bull and Beckwith 1993;

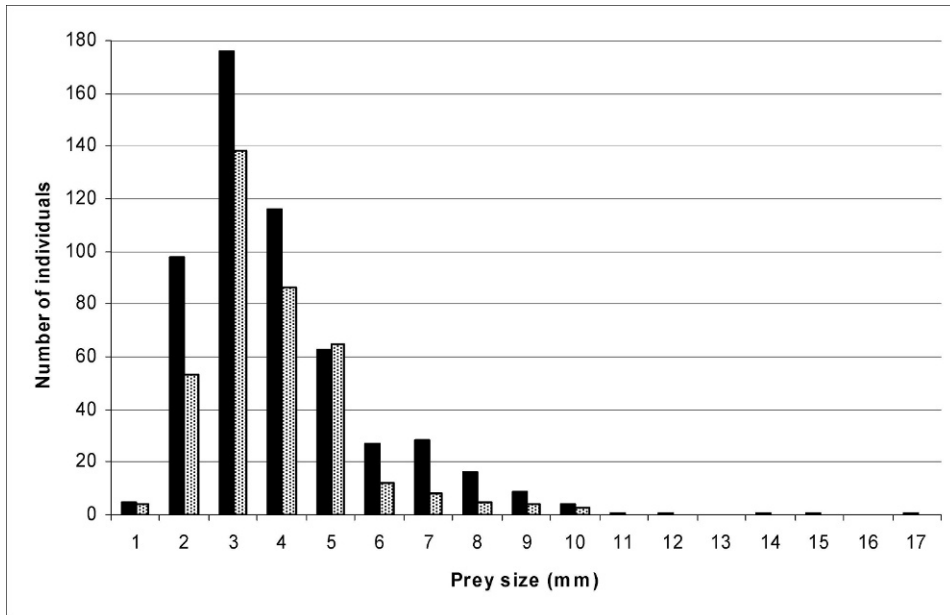


Fig. 4. Sizes of food items delivered to chicks by White-throated Swifts at the same location in southern California in 1997–2000 (black bars) and 2001–2004 (shaded bars).

Tarburton 1986, 1993). The mean prey size taken by White-throated Swifts in both sampling periods is similar to the mean prey size taken by six similar sized swifts in the genera *Apus* and *Tachymarpis* where there is a significant positive correlation between prey size and adult body weight (Collins et al. 2009).

Survival rate, mate and nest site fidelity

White-throated Swifts occupied most or all of the available sites at the study location in all years of this study. Continued site utilization was also noted at other locations in southern California (Bailey 1907; Skinner 1933; Collins 1973). Elsewhere they have been observed at the same nest sites over much longer time intervals (Dobkin et al. 1986). Such traditional nest-site use suggests a high survival rate of adult breeders. No predation on adult White-throated Swifts was documented in this study. One brood of four chicks 9–11 days old, two chicks 30–31 days old in a brood of four, and one chick 35 days old in a brood of three disappeared but no predator was identified.

The small number of adults banded in this study precludes a detailed survival analysis. In addition, not all breeding adults were captured, or recaptured, each year due to the probable disruption of chick provisioning and possible desertion. The available data indicates that 73.9% of the adults were known to be alive from one year to the next. This

Table 3. Annual variation in prey body sizes (mm) taken by White-throated Swifts from the same nesting location in different years in southern California.

Sample	Years of collection	Number of prey items	Mean prey size (mm)	SE	Range
Boluses 1–5	1997–2000	547	3.9	0.09	0.7–16.7
Boluses 6–9	2001–2004	378	3.7	0.08	1.4–9.9

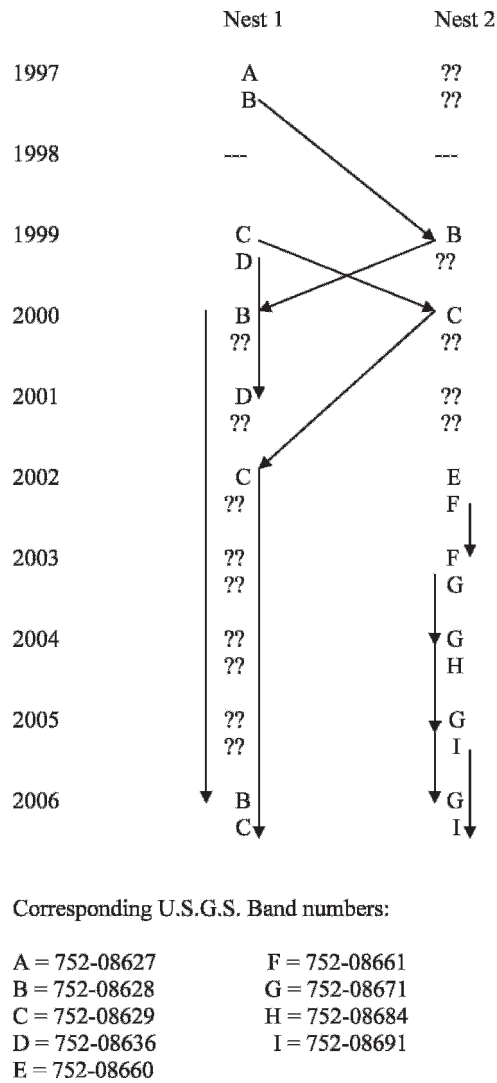


Fig. 5. Nest site and mate site fidelity of banded White-throated Swifts in southern California. No data were collected in 1998. Sexes were not determined. No attempt was made to capture all adults each year to avoid disturbance and possible desertion.

is a minimal value as it does not include the probability that others were alive but not recaptured or had emigrated to other nest sites at this or a more distant location One adult banded in July 1997 was still present and breeding in June 2006. The age of first breeding in White-throated Swifts is not known. If it is assumed to be when they are one year old then this individual would have been 10 years old when last recaptured. Similarly, another individual was eight years old when last recaptured in 2006.

Nest site fidelity was variable in this study (Figure 5). One individual moved from nest hole one in 1997 to nest hole two in 1999 and was found back at nest hole one in 2000. Another individual was at nest hole one in 1999, nest hole two in 2000 and back at nest hole one in 2002. These two individuals were together at nest hole one in 2006 and were probably there together from 2002 to 2006 but were not recaptured during this interval.

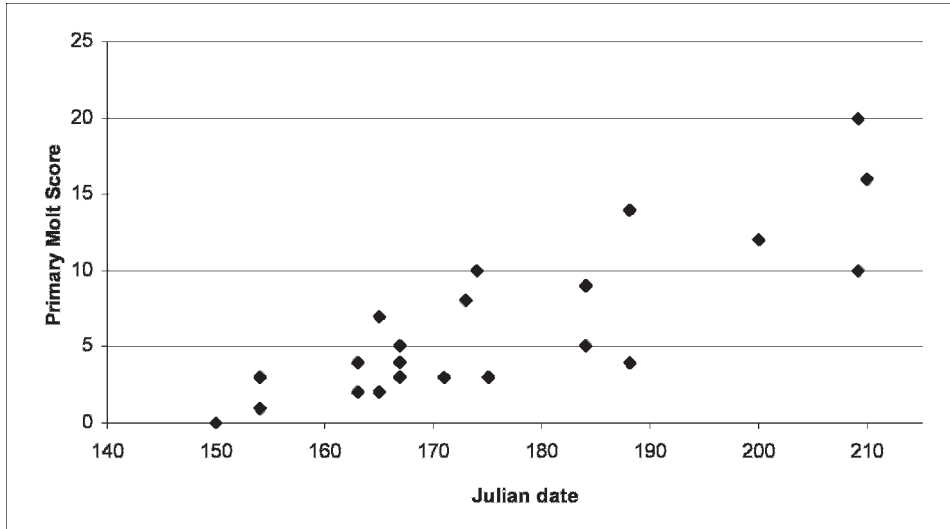


Fig. 6. Comparison of molt score of primary feathers and Julian date in White-throated Swifts in coastal southern California. Julian dates: June 1 = day 153, June 15 = day 167, July 1 = day 183, July 15 = day 197. For explanation of molt scores see methods.

This would be the longest duration of a pair bond in this species. One additional pair was together at nest hole two in both 2005 and 2006 (Figure 5).

Annual survival rates of adult swifts are generally higher than the rates for other similar sized terrestrial bird species and approach the values for some traditionally long-lived seabirds. Survival estimates for three European swifts ranged from 74% to 84% (Lack and Arn 1953; Arn-Willi 1960; Perrins 1971; Boano et al. 1993; Thomson et al. 1996) and 85% for one Neotropical species (Collins 1974).

Data on mate and nest site fidelity in swifts is limited. In a study of the Pallid Swift in Italy (Boano et al. 1993), some individuals repeatedly changed nest cavities and mates from year to year; one male nested in five different cavities with four different females in successive years. On average Pallid Swifts changed mates 58.3% of the time in successive years. The greatest mate fidelity recorded was a pair of these swifts found together for three breeding seasons (Boano et al. 1993). In the Common Swift, pairs often remain together for many years (Weitnauer 1990). In a study of 47 pairs, mate fidelity averaged 3.9 years with one pair staying together for 13 years (Weitnauer 1990). However, some breeders dispersed and were recaptured at other colonies 6–36 km away (Weitnauer 1990).

Adult Molt

Adult White-throated Swifts molt their flight feathers once a year, a process that may take up to 6–7 months (Marin 2003). The molt of the tail and body contour feathers begins after the molt of the primaries are well advanced (after primaries 4–6 have been replaced) and are completed at the same time or shortly before completion of the molt of the primaries (Marin 2003). In this study, the annual molt began in early June with the replacement of the innermost primaries; two individuals caught in late May had not begun to molt (Figure 6). The molt progressed slowly but steadily (from innermost outward) through late July when typically, the first two or three primaries had been replaced and the next was being regrown (Figure 6). Usually only one or two primaries

were in molt at the same time with the next outermost feather being dropped when the preceding one was about 2/3–3/4 regrown. No molt of the tail or body contour feathers had begun during the term of this study.

The timing of primary feather molt was very similar from year to year (Figure 6). Individuals captured multiple times over the course of this study likewise showed substantial agreement in the stage of primary molt on similar dates in different years. Little year-to-year variation in the timing of molt was also noted in a desert breeding population of White-throated Swifts (Marin 2003).

In this study, the onset of the annual molt overlapped broadly with the breeding cycle. The molt of the primaries began in early June, which was at the end of egg-laying period and in the middle of the hatching period of the chicks. The molt progressed throughout the chick-rearing period, which ended in late July; the molt presumably continued, as in other populations (Marin 2003), for several months thereafter.

In a desert inhabiting population of White-throated Swifts at least some individuals began laying eggs in early April (Marin 2003) and some initiated molt in late April or early May although the majority did not start their molt until late May or early June (Marin 2003) as also shown here for a coastal population. This resulted in a decreased degree of overlap of molt and breeding in the desert population. Other studies have documented a broad overlap in the molt and breeding seasons in many species of swifts (Collins 1968; Marin and Stiles 1992; Bull and Collins 1993; Tarburton 2003, 2009; Collins unpublished data). Molt-breeding overlap is also shown in this study of a coastal population of White-throated Swifts. The strong correlation between molt stage and date with little inter-year variation in the timing of molt initiation, but not the start of breeding, (Marin 2003; this study) suggests that the onset of breeding and the annual molt in White-throated Swifts, and possibly other species of swifts (Collins 1968), are triggered by differing environmental stimuli.

Although much information has been gathered to date about the biology of White-throated Swifts, some of it is almost anecdotal. Thus, there is still much more to be learned about this species. Such additional information will facilitate more detailed comparisons with data currently available for other species of swifts.

Acknowledgments

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